SYNOPSIS

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A Study on the Macro Models to Simulate the Seismic Response of Masonry-Infilled Reinforced Concrete Frames

Abstract

Reinforced concrete (RC) frame structures with masonry infills are commonly used in India and across the world. The lateral force-displacement response of these structures has been a subject of study for decades. Two broad classes of models are used to simulate the seismic response of the infilled RC frames: 1) micro-models, wherein each constituent of the structure is considered explicitly, and 2) macro-model through which broad response parameters of the structure can be captured. This study focuses on the macro modelling approach of infilled RC frames.

A macro model for an infilled RC frame comprises of straight elements representing the beams and columns, and another set of straight elements, arranged along or around the diagonal of the RC frame, representing the masonry wall. The second sets of elements are also known as 'struts'.

Numerous models have been developed in the past considering different numbers and orientation of struts, and their constitutive models. Seven strut models and eight constitutive models have been evaluated in the present study (a total of 56 macro models for infilled RC frames) by comparing the experimentally observed and analytically predicted response of 35 one-bay-one-story infilled frame specimens tested experimentally (a total of 56 × 35 = 1,960 pushover analyses). The performance is quantified in terms of the ratios of analytically predicted and observed values of initial stiffness, peak strength and residual strength. The prediction of the flexural and shear failure in the beams and columns is also evaluated. Macro models with three struts performed well overall. Two-strut models with off-diagonal struts only were found to predict the peak strength and the post-peak response poorly due to shear failure in the columns at initial stages of loading. The single-strut model (also incorporated recently in the Indian earthquake code) led to a good prediction of the initial stiffness and peak lateral strength, but poorly captured shear failure in columns and post-peak behaviour of the infilled frame. Different constitutive models were found to result in better prediction of initial stiffness, peak strength, and post-peak response. The three strut model with off-diagonal struts parallel to the diagonal strut was considered for further study. Suitable modifications were made in the "best" constitutive models to arrive at the final constitutive model for the struts. This combination of strut and constitutive model can be used to predict the failures associated with the RC members (e.g., flexural, shear) and the failure along the diagonal in the masonry panel (e.g., diagonal shear, corner crushing).

A modification in the final strut-cum-constitutive model was made to enable it to also capture the sliding shear mode of failure. Five existing models to predict the sliding shear capacity of masonry panel were considered. It was observed that none of the models could result in a decent prediction of the sliding shear failure (best success rate in prediction was 63%). The concept of an additional strut-cum-constitutive model has been proposed, which can be evaluated in future.